CHAPTER 10

DATA TRANSMISSION SYSTEMS

1. UMCS DATA TRANSMISSION TOPOLOGIES.

a. UMCS data transmission networks are defined as peer-to-peer networks where all nodes (island station computer, workstations and field equipment panels) have the same level of control over the communications and can control their own activities. In the UMCS, peer-to-peer network data is stored in many locations (distributed processing) and the island station computer takes the role of a server. UMCS network topology describes the physical layout of the data transmission system. UMCS data transmission system topologies include the following.

(1) Point-to-point is a dedicated connection between two devices.

(2) Bus topology is a form of multinode local area network (LAN) data transmission system. In a bus network all the devices connect directly to the same media by means of connectors in a daisy chain configuration. Bus LANs include token-passing LANs and ethernet LANs which utilize carrier sense multiple access/collision detection.

(3) Star topology is a configuration in which the UMCS island station computer or a communications hub connects radially to multiple field equipment panels. Star topologies include token ring, where the ring is internal to a multistation access unit, and hub ethernet, which is also called 10 Base-T.

(4) Hybrid topologies (combination bus and star) are used in an arcnet network, which is a token-passing network.

b. The UMCS data transmission system is also defined by the data transmission media used. Guided or physical media consists of fiber optics, wireline and coaxial cable. Unguided media consists of one-way radio frequency (RF) or two-way RF packet transmissions.

c. The selection of UMCS data transmission system topology will be based on the size of the system. Arcnet-based networks are limited to 256 nodes. Ethernet-based networks can be extended over 1000 nodes based on addressing capabilities, but the practical number is much lower because the collision detection nature of ethernet will limit network performance as the network size grows. The use of 10 Base-T hubs and multiple network segments can improve ethernet performance.

d. Data transmission between smart field panels and remote terminal units, universal programmable controllers or unitary controllers typically uses a bus topology.

e. Network interconnection devices, including hubs, bridges and routers, extend or interconnect networks or network segments.

(1) Active or passive hubs provide a central location for the connection of cables from network devices such as field equipment panels, workstations, and other hubs. Active hubs regenerate signals between devices connected to them. Passive hubs pass the signals from one port to the next without signal conditioning or regeneration.

(2) Bridges provide a communication path between two or more network segments. Bridges enable devices on one network segment to communicate with devices on another network segment. Bridges allow only those packets destined for the other network segment to be passed.

(3) Routers connect network segments (or different networks using identical protocols) of different media types. Routers are the basis for large internetworks made up of smaller networks each with its own logical identity. Routers direct packets between networks using the most efficient route based on packet type, destination and available network resources.

2. FIBER OPTICS.

a. Fiber optics uses the wideband properties of light traveling through transparent fibers. Fiber optics is a reliable communications media best suited for point-to-point high speed data transmission. Fiber optics is immune to radio frequency electromagnetic interference, and does not produce electro-magnetic radiation emission; hence, fiber optics can be used in secure areas.

b. Fiber optic cable consists of small fiber cores encased in a thin, light-reflective plastic or glass jacket referred to as the cladding. The cladding is enclosed by a thicker plastic or teflon jacket. A light source at one end of the cable introduces coded light pulses into the fiber. The light source may be a laser diode or a light-emitting diode (LED). The light pulses are transmitted through the fiber to a photo diode at the other end, which receives the light pulses and converts them to electrical signals. Fiber optic cables (but not fiber optic equipment) can be installed in explosive and flammable environments. Fiber optic cables can tolerate severe weather conditions and can be immersed in many fluids with appropriate jackets. The bandwidth of this media is virtually unlimited, and extremely high data transmission rates can be obtained. The signal attenuation of high quality fiber optic cable is very low. The type of fiber optic cable typically used for UMCS data transmission is multimode fiber with 62.5 - micron fiber diameter. When the data transmission system interfaces with existing government furnished networks, however, the designer will evaluate the specific fiber required for interface or extension.

c. The use of fiber optics in a data transmission system requires that equipment be provided to encode, decode and regenerate digital data into the fiber optic media. Typical fiber optic equipment includes the following.

(1) Fiber optic modems allow full duplex, asynchronous, point-to-point communications. Fiber optic transmitter and receiver modules which convert electrical digital signals into optical signals are an integral part of fiber optic modems.

(2) Fiber optic repeaters extend the range of the fiber optic data transmission. A repeater is a signal regenerator used at specified distances to restore signals to their proper level and quality. Repeaters can be simplex (containing one transmitter and one receiver module) or duplex (containing two transmitters and two receiver modules). Repeaters are required for distances between data transmission equipment of 1 to 2 miles.

(3) Fiber optic transceivers convert signals between fiber optics and other UMCS communication media. One type of fiber optic transceiver converts an ethernet 10 Base-T (wireline) signal to a 10 Base FL (fiber optic) signal.

(4) Fiber optic drop/repeaters combine the features of fiber optic repeaters with fiber optic LAN transceivers in a multidrop bus topology.

(5) Fiber optic active star units (or fiber optic switched hubs) extend a fiber optic bus topology into a multi-segment star topology.

d. The use of fiber optics equipment and connectors will introduce optical signal losses/gains that must be accounted for during the design. Optical flux budget/gain will be calculated during UMCS data transmission system design.

3. WIRELINES.

a. Wirelines are twisted pairs that consist of two solid copper insulated conductors twisted and shielded together to minimize interference by unwanted signals.

b. Twisted shielded pairs carry information over a wide range of speeds depending on line characteristics. To maintain a particular data transmission rate, the line bandwidth, time delay, or the signal to noise ratio may require adjustment by conditioning the line. Twisted pairs are permanently hardwired lines between the equipment sending and receiving data. The nominal bandwidth of unconditioned twisted pairs is between 300 and 3000 Hz. For each Hz of available bandwidth, 2 bps may be transmitted. Data transmission in unconditioned twisted pairs, in most cases, is limited to a speed of 9600 bps or less. Hardwired twisted pairs must be conditioned by the supplier in order to obtain operating speeds up to 19.2 Kbps. Data transmission between field equipment panels is by means of twisted pairs connecting line drivers operating at a speed selected by the system.

c. To implement a wireline data transmission system, it is necessary to encode the data for transmission over the media using modems or line drivers.

d. The modem is a device which performs encoding and decoding of digital data by modulation and demodulation. The most commonly used format is frequency shift keying (FSK) of digital data into a series of "marks" and "spaces" represented by two audio tones. Modems are provided with sharply tuned filters which eliminate interference outside the normal pass band of the "marks" and "spaces" audio tones. Modems for UMCS operate at a speed up to 9600 bps using V.42 error correction and V.42 bis data compression.

e. A line driver is a hardware device which supplies sufficient output power to transmit digital signals over miles with balanced lines, such as between field equipment panels. The line driver output is a low power output transistor. Optical isolators are used as protection devices in the line driver output. Line drivers for UMCS operate at 9600 bps.

4. 10 BASE-T. 10 Base-T is an ethernet physical star topology with a data transmission speed of 10 Mb/s, utilizing wirelines with a maximum segment length of 100 meters. The segment length can be extended to 150 meters when 10 Base-T transceivers are used. 10 Base-T hubs typically have up to 12 ports. They are stackable to provide expansion of the number of ports. 10 Base-T hubs are selected with ports for attachment to fiber optic or coaxial cable LANs, and connect to UMCS workstations or other computers through network interface cards.

5. COAXIAL CABLE.

a. Coaxial cable is used as a communication media in some central station or island station LANs. Its use is typically limited to within a single building because of its susceptibility to electromagnetic interference.

b. Thick coaxial cable (10 Base-5 ethernet cable) is a 0.4 inch diameter cable that requires transceivers at nodes and has a distance limitation of 500 meters. The ends of a thick coaxial cable LAN are terminated using N-series terminators. Thick coaxial cable ethernet LANs will support a maximum of 100 nodes per segment.

c. Thin coaxial cable (10 Base-2 ethernet cable) is a 0.2 inch diameter cable that does not require transceivers at nodes and has a distance limitation of 186 meters between nodes. The ends of a thin coaxial cable LAN are terminated using BNC terminators. Thin coaxial cable LANs support a maximum of 30 nodes per segment.

d. Coaxial cable shieldings are grounded at one end.

6. RADIO FREQUENCY (RF).

a. Modulated RF data transmission systems can be used for UMCS with the installation of radio receivers and transmitters (a combination receiver/transmitter is referred to as an RF transceiver). The data signal enters a transmitter terminal where it modulates the RF carrier wave. After traveling through through the communication media, the modulated RF carrier enters a receiver terminal where it is amplified and demodulated back into the original data signal. Modems must be provided at each receiver/transmitter location. Frequency modulation is used instead of amplitude modulation because it is not susceptible to amplitude related interference.

b. RF systems can be effectively used for two-way communication between the island station and field equipment panels where other communication media is not available or suitable for the application. One-way RF systems can be effectively used to control loads at remote locations such as for unitary heaters in warehouses and in family housing applications. The use of RF will be coordinated with the communications officer to avoid interference with other existing or planned facility RF systems.

7. PACKET RADIO.

a. Packet radio is a two-way data transmission method utilizing a protocol similar to the CCITT X.25 protocol used for packet data transmission over wirelines. Using this protocol, data can be transmitted either on a single frequency dedicated for data transmission or on existing voice channels (although not simultaneously with voice transmission). Networks can be established on a polling or report-by-exception basis, or a combination of both.

b. Equipment required at each communication node for a packet radio data transmission system include a packet modem and controller designed to be used with a radio, and an RF transceiver. The RF transceiver, packet modem and controller may be separate or may be integrated into a single device.

8. GOVERNMENT-FURNISHED DATA TRANSMISSION SYSTEMS. For large installations, a substantial portion of the cost of a UMCS is related to the physical installation of data transmission media (wirelines or fiber optics). Depending on the extent, condition and availability of government-owned communications infrastructure on an installation, the cost of the UMCS may be reduced through the use of government-furnished data transmission systems. Coordination with the communications officer is required to verify the reliability of the existing data transmission systems. The designer will determine and show in the design the characteristics and extent of government-furnished transmission systems as well as extensions, interfaces and equipment to be provided by the contractor to provide an operable system.